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ELECTRIC CONTROLS FOR AUTOMATIC FEED HANDLING [1/]

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Electricity is a versatile form of power. It is convenient and easy to use. Electricity is most economical when it is used productively a greater percent of the time. It is desirable to spread out electric loads over the longest time base possible in order to achieve the most economical electric rates and to reduce the cost of installing and owning electric equipment and electric wiring to service that equipment.

Feed grinding for materials handling on the farm has been traditionally handled by large power units. The source of this power has been the farm tractor. It is not feasible to substitute electric power for the farm tractor to operate the same type of equipment; to do so would result in an unreasonably high cost for the service performed. It is much more desirable to use small-horsepower equipment, which results in reduced capital investment and lower operating cost. The convenience of electric power is lost if a man must stand by to regulate the operation of small-horsepower, small-capacity electric equipment. If the operating period of equipment is extended and its capacity reduced, it becomes desirable to use automatic controls to operate the equipment. Electric power is easily submitted to automatic controls; because of this convenience its use on feed handling equipment is becoming more common.

Automatic electric controls consist of a series of sensing devices that give a yes or no answer relative to the status of a desired variable. Some force directly related to the variable in question can be obtained to operate a set of contacts. Once this is available as a function of the variable to be controlled, most any control sequence can be arranged. Heat, light, weight, tension, compression, movement, and a host of other variables can be used to actuate switches and achieve automatic control of materials handling systems. The proper one must be chosen for smooth and efficient operation.

1/ The work reported in this paper is a result of cooperative research between the Farm Electrification Research Branch, Agricultural Engineering Research Division, ARS, USDA, and the Agricultural Engineering Department, Illinois Agricultural Experiment Station, Urbana, Illinois.

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Automatic control may exist in any degree, from the control of one simple function to the complex integration of dozens of interrelated functions. The latter is usually referred to as automation. Partial automation, that area between the two extremes, is the most practical for materials handling systems. Simple repetitive operations are regulated by automatic controls and the more complicated functions by a human operator. The latter would consist of corrective measures that would require the interpretation of several factors and infrequent operational changes.

The electric time switch is both simple and very useful for the control of materials handling equipment. The time switch can regulate both the frequency and the duration of repetitive operations. This becomes very meaningful when you consider that most feed handling equipment has a constant processing rate. The constant processing rate is required if the equipment is to perform at maximum capacity and efficiency. It is possible with the time switch to regulate the amount of feed that is processed each operational period, as well as the number of operations that occur per day or per week or according to any time base that is desired.

The manually reset interval timer is used to control the operational period of equipment. This may be a fan, an outside lamp, a feed grinder, or a conveyor. Setting the timer turns the equipment on; the adjustment of the timer determines how long the equipment will remain in operation. Twenty-four-hour timers, which will turn equipment on for a fixed period of time at the same hour each day, can be used. Modifications of these timers can be obtained which will omit the duty cycle during certain days of the week. Two types of timers are shown in figures 1 and 2.

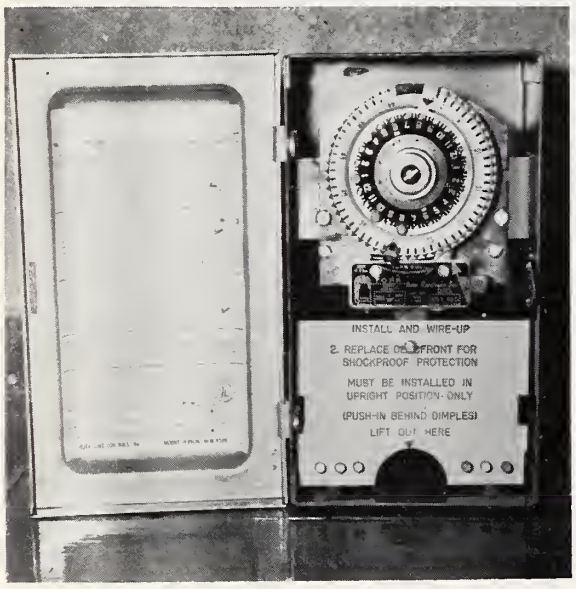


Figure 1.--This 24-hour timer is capable of turning a circuit "on" for a period of 2 to 55 minutes any hour on the hour every day. A pin is inserted in the center dial for each hour the circuit is to be energized.

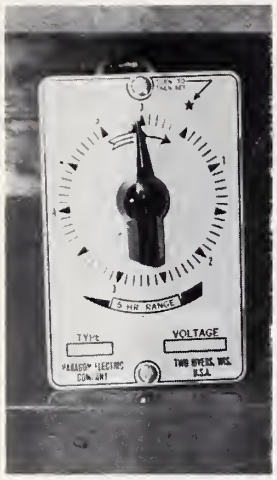
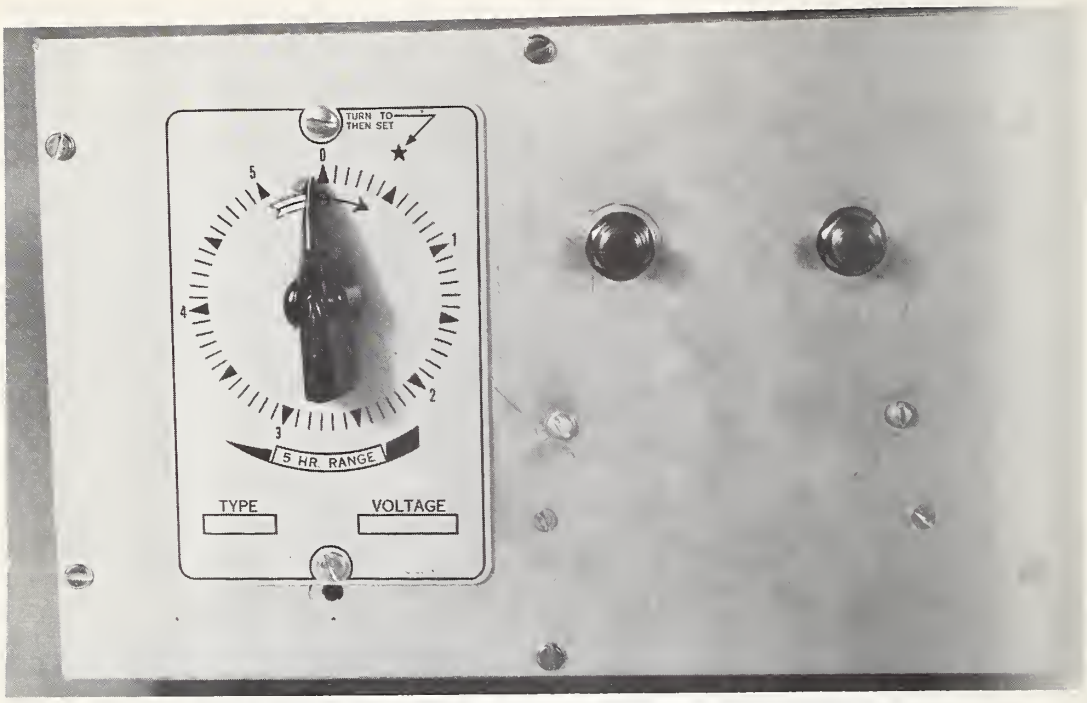


Figure 2.--Interval time switches may have an electric or spring drive. The one shown is electrically driven and has a range of 10 minutes to 5 hours. It will open or close an electrical circuit at the end of the preset time period.

Automatic time delays can control the sequence of several operations. This is very useful in materials handling because it is often necessary to start and stop several pieces of equipment in a definite order. It is much safer and much more convenient to have this sequence controlled by automatic devices than to rely upon manual control and human memory. A combination of an interval timer and two time delay relays are shown in figure 3 for the control of a feed grinder and conveyor. For the satisfactory operation of these two pieces of equipment the conveyor must start several seconds before the feed grinder and the feed grinder must stop several seconds before the conveyor. This prevents the plugging of equipment with feed and unnecessary shut-downs due to accumulation of the feed in the conveyor. The circuit for this controller is shown in figure 4. Another feature of this control combination that should be noted is the incorporation of the overload control of the conveyor motor in the controller circuit. This assures safe operation of all equipment; if the conveyor motor were to overload and to stop, all of the equipment in the operation should be stopped. This controller is wired to turn off the grinding mill if the conveyor motor stops.

The pressure switch is another very useful control device in materials handling systems. The pressure switch is used to detect the presence or absence of material on the pressure plate of the switch which will open or close a circuit. A simple design of a pressure switch is shown in figure 5. This switch can be used to turn off a conveying system after a feeder or a bin has been filled. It also can be used to start the conveying system and feed preparation equipment when the feeder or bin is emptied. An auger-feed distribution system is shown in figure 6. Automatic feed distribution controls for this system are shown in figure 7. Pressure switches and multiple-contact relays have been used in this control system to provide completely automatic feed distribution from a supply point to any one of four distribution points. The relays for each distribution point are interlocked electrically so that only one will be in control at any one time. The order of control is determined by the wiring sequence.



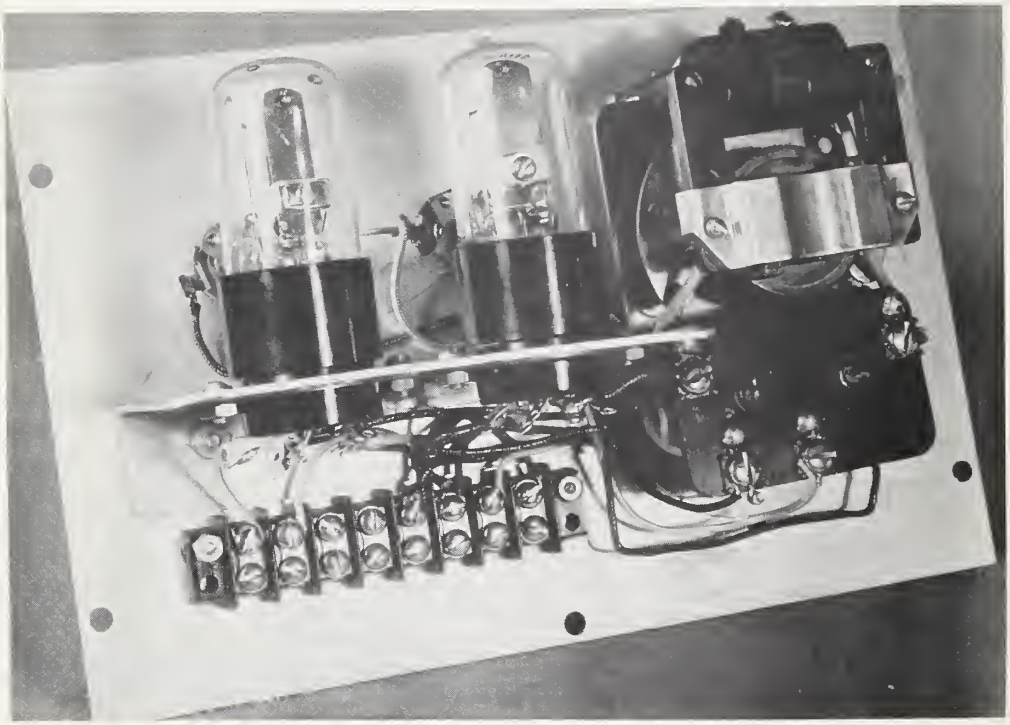


Figure 3.--Front and rear view of an operation controller for a feed grinder and conveyor, which consists of an interval time switch and two thermal time-delay relays.

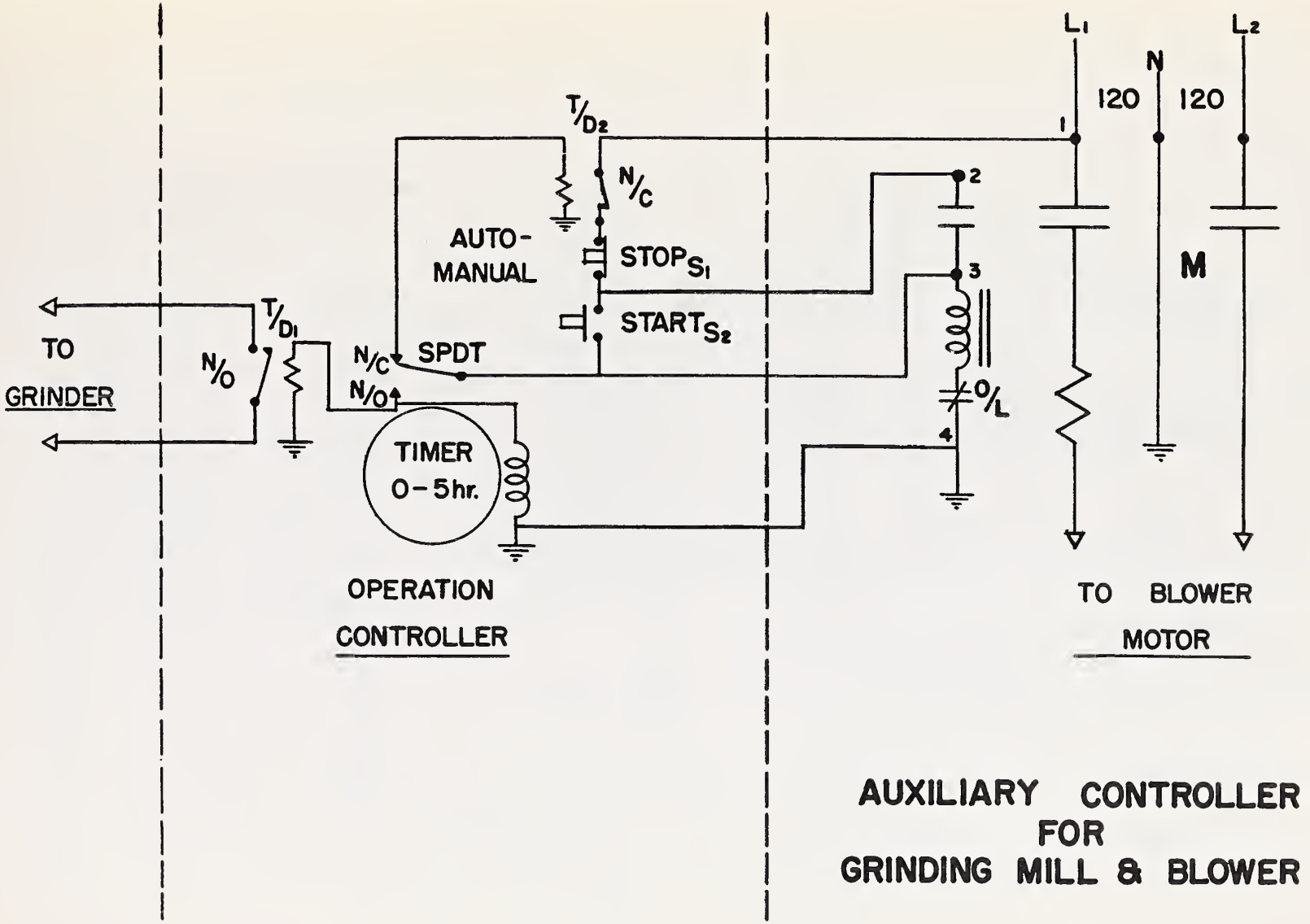
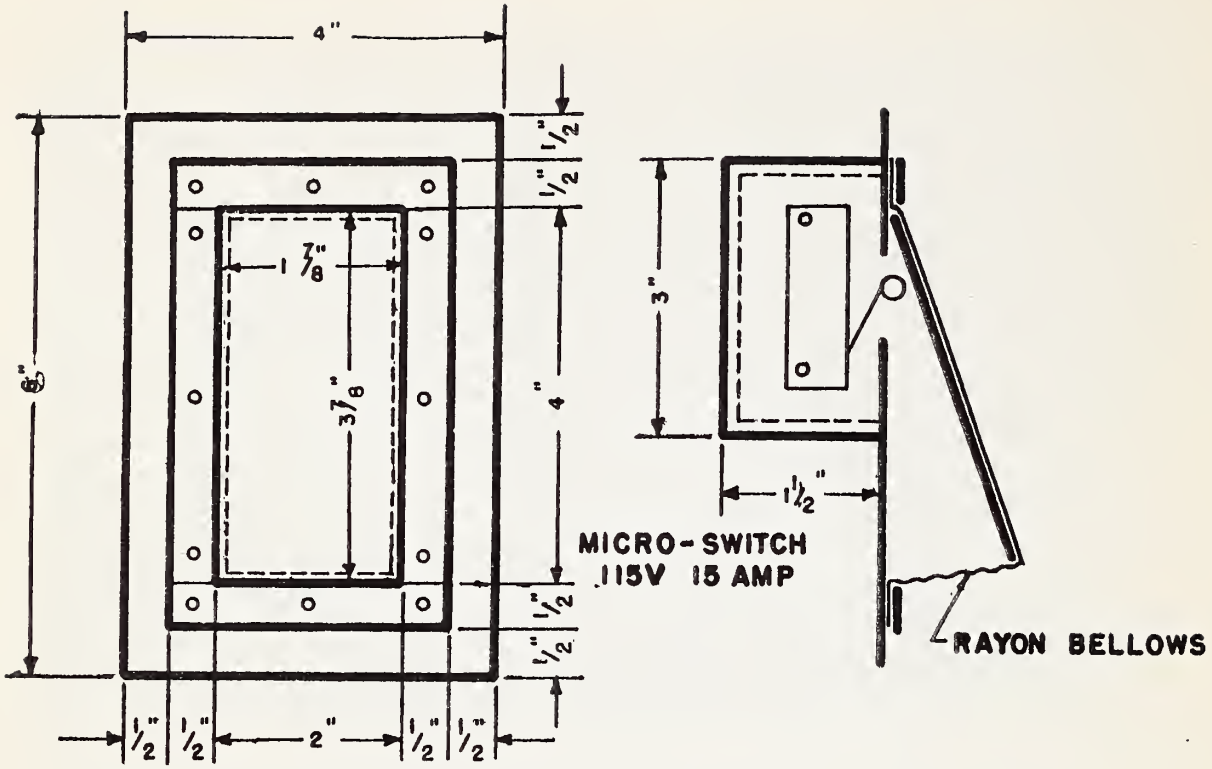
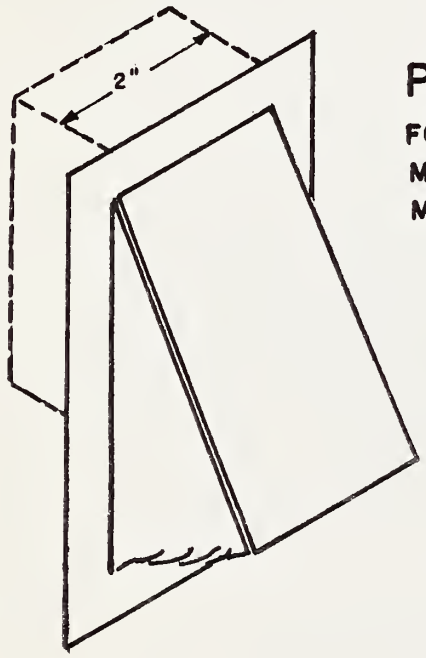


Figure 4.-- Schematic of operation controller.



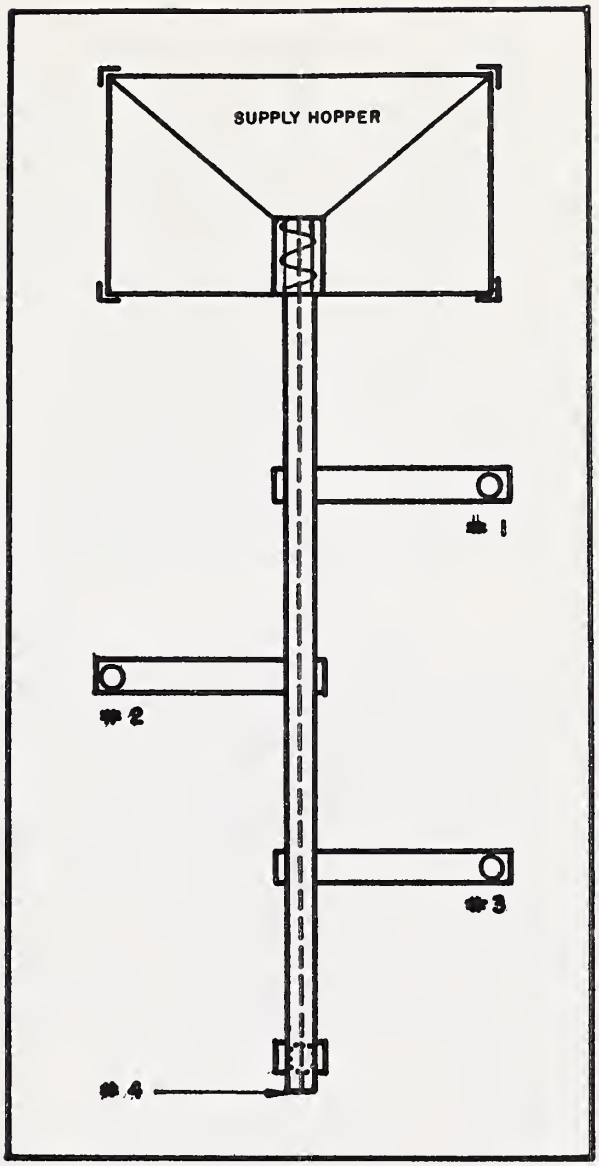


ISOMETRIC

PRESSURE SWITCH

FOR CONTROL OF AUTOMATIC MATERIALS HANDLING EQUIPMENT

Figure 5.--The pressure switch is a very useful materials handling control.



PLAN OF AUGER FEED DISTRIBUTION SYSTEM

Figure 6.--An auger feed distribution system may consist of a single auger or several augers as shown above. The feed material is dropped from the main auger into the distribution augers.

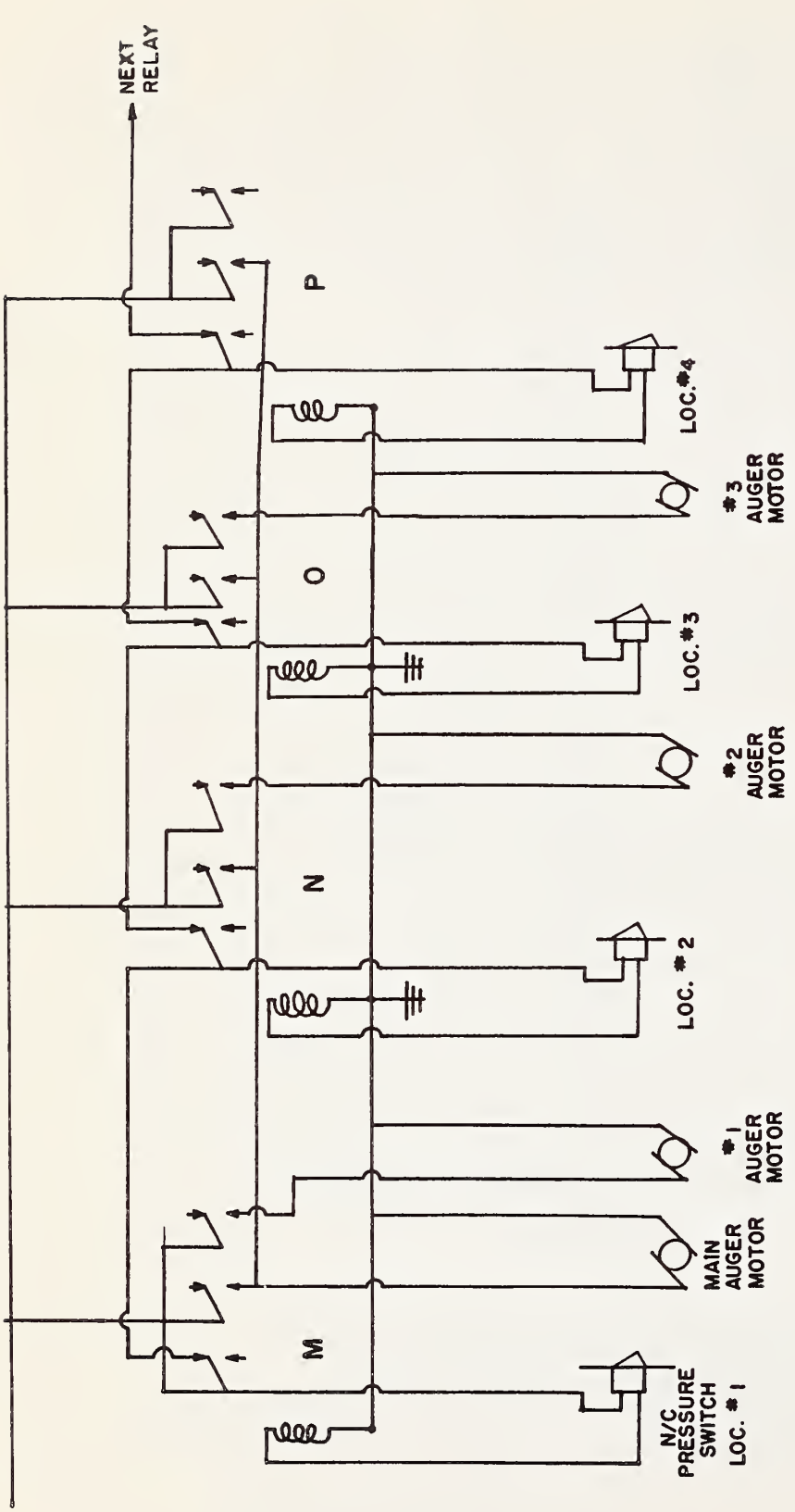


Figure 7.--This is a schematic of an automatic control system for an auger distribution system.

The interlocking of electric controls in an automatic system is important and it is easily done with the proper combination of relays and switches. The control system described above for the automatic auger-feed distribution system could use double-pole, single-throw relays and single-pole, double-throw pressure switches to accomplish the same type and results of control. The switch unit used on the pressure switches will normally be a single-pole, double-throw type. In order to achieve an electrical interlock with the single-pole, double-throw pressure switch, a three-wire connection would be required to each pressure switch instead of two-wire. In some systems this may be undesirable and inconvenient. It is usually better to use the double-throw relays and two wires from the pressure switch. All controls should be interlocked. This should be carried to the maximum extent possible to include all critical operating equipment, the failures of which could result in serious damage either to the ration or to the operating equipment. The interlocking of safeties requires that magnetic or thermal overloads be used on the equipment. Each overload unit has an interlock switch. These switches are wired in series so that each piece of equipment is dependent upon each overload relay.

Many other types of automatic control devices are now being used on some materials handling equipment and are coming into more general use. They are more complicated in their application and use. The current-sensitive relay is an example of this type of control. It is very similar to the magnetic overload relay in that it either opens or closes a pair of contacts at a preset current level and will close these same contacts or open them when the current level drops to a predetermined value. This type of control may be used to maintain a uniform load for peak operating efficiency on a piece of processing equipment. An example might be the automatic raising and lowering of a silage unloader to accomplish automatically what now a man must stand by to do. A circuit using this type of control in a flat-bottom-bin unloader is shown in figure 8. More controls are going to be required as we become more dependent upon automatic equipment to achieve efficient low cost operation.

Electric power is our most versatile form of energy. With the proper combination of machines and controls, the possibilities of farmstead mechanization are almost limitless.

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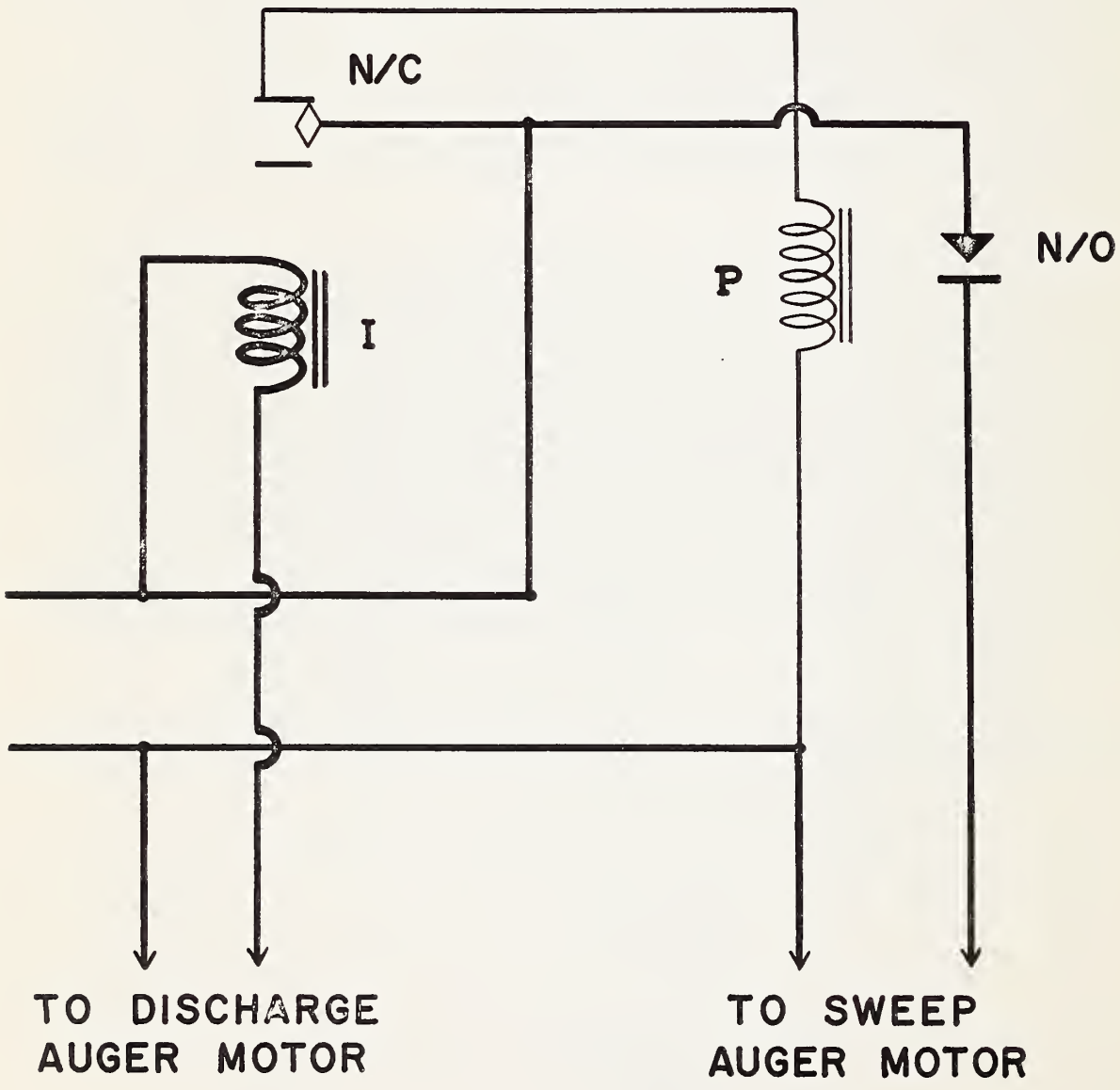

Figure 8.--Current relay controller for automatic flat-bottom-bin unloader.